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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Magnetically - and Visually - Coded Tagging Wire, and Method of Making Such Wire

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Notice: This application is as filed and may therefore contain an incomplete specification.

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MAGNETICALLY- AND VISUALLY- CODED TAGGING WIRE, AND METHOD OF MAKING SUCH WIRE

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a device for tagging a macro-organism, particularly a fish, with a tag including visually-readable binary information. The information is coded on a wire, which is implantable on the macro-organism for later reading. The wire from which the tags are made is additionally magnetically coded, so that a reading and verification device can be used during manufacture and just prior to tag implantation to verify information relative to the tags and wire used. The present invention also relates to a method for producing and using such a tag and wire.

DESCRIPTION OF THE PRIOR ART

U.S. Patent No. 3,820,545 describes a tag for a macro-organism in the form of an implantable wire, in which binary data, in the form of visually-readable notches or indentations on the surface of the wire, are coded. Tags made according to the description in that patent are typically produced as a continuous length of wire with tag segments along the wire length. The tag segments are cut into individual tags as they are injected into the macro-organism, generally a fish. Such tags have been manufactured using, typically, 0.25 mm diameter X 1.0 mm long segments of specially processed 300 series stainless steel wire. From the

time the tags are coded, verification of the data encoded on the wire prior to implantation in a fish requires time-consuming visual inspection of the tag material under a microscope. Such an arrangement can lengthen the time required to verify that the proper tag and wire is being used prior to injection, thus slowing the tagging process.

U.S. Patent No. 4,679,559 describes an apparatus in which an implantable tag for a macro-organism may be magnetized so as to facilitate implantation of the tag and to inhibit unwanted removal of the tag from the macro-organism. The apparatus for magnetizing the tag is designed to facilitate the insertion process of tags coded with visually-detectable information, and the magnetic feature does not provide any decodable information regarding the tag or the wire. The wire used with this device therefore has the same limitations as discussed above -- namely, the difficulty of verification of the code on the tag because of the need for visual inspection of that code.

SUMMARY OF THE INVENTION

The present invention concerns an apparatus and a method for providing visual coding of binary information on a macro-organism-implantable tag, in addition to magnetic coding of the wire from which the tags are made, such that the binary information contained in the tags can be easily verified via the wire using an electromagnetic and electronic verification apparatus which is a part of the tag implanting device. In particular, the present invention concerns a method and apparatus for coding binary information both magnetically and visually on a wire used for making binary tags, which tags are thereafter implantable in fish and may be encoded visually.

The present invention includes an implantable wire tag in which binary information is coded digitally using a pattern of notches or any other visually discernable marks, while the same data, plus any supplemental information, is magnetically coded on the wire from which the tag is made for the purposes of verification of tag data during the tag production and application process -- including, inter alia, automatic reading and display of the data by the tag injector.

In the tag of the present invention, a coding apparatus codes magnetically and continuously along the length of the wire medium the same binary digits which are mechanically coded on each wire segment surface. Additionally, the coding apparatus may magnetically code supplemental magnetic information on the wire. The supplemental information could include additional code from other formats, code for error checking, or code representing a production order number of the wire material. The magnetic coding and the mechanical coding preferably would be done by the same apparatus, thereby assuring that the same code is placed on the wire segment in both forms.

After coding of the wire, the wire can be decoded fairly simply during the remaining production process, using a magnetic reader. Additionally, the magnetic code on the wire could be read and the code displayed by a magnetic reader in the injection device, during the final steps of the tagging process.

The present method and apparatus allow significant improvement in the speed and reliability of wire production and processing, and also ensures final system reliability by verifying that tags being implanted actually carry the data which they are intended to carry and which the operator assumes is being carried by the macro-organism after tagging.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a lengthwise view of a length of wire magnetically encoded according to the method and apparatus of the present invention;

Fig. 2 is a graph showing the magnetic field strength of the section of wire of Fig. 1;

Fig. 3 is a graph showing the induction induced by the wire of Fig. 1 in a reading device;

Fig. 4 is a graph showing the encoded clock pulse and binary data information extracted from the wire section shown in Fig. 1 via the signal of Fig. 3;

Fig. 5 is a graph showing the binary signals encoded from the section of wire shown in Fig. 1;

Figs. 6 and 7 are cross-sectional and front views of an apparatus for magnetically and visually coding the wire of the present invention, as well as reading the code after it has been coded on the wire; and

Fig. 8 shows a device for reading coded wire and injecting wire tags into a macro-organism according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a wire 1 section made with the method and apparatus of the present invention, in which a plurality of magnetic blocks 2_1, 2_2, ... 2_7, are provided. In Fig. 1, the leftmost section 2_0 of wire 1 is uniformly magnetized, so as to create a small and nominally uniform magnetic field M_0 which acts as a magnetic leader for the wire 1 section. To the right of the leader section 2_0, the wire 1 section is divided into a series of magnetized blocks 2_1, 2_2, ..., which blocks have directions of magnetization which are opposite that of an immediately adjacent block. The magnetic fields produced by the blocks 2_1, 2_2, ... are shown by the arrows M_1, M_2, ... The blocks 2_1, 2_2, ... are of two different lengths: short blocks (e.g., blocks 2_1, 2_2, 2_4, 2_5) and long blocks (e.g., blocks 2_3, 2_6, 2_7). The long blocks are generally twice the length of the short blocks.

The blocks 2 are coded upon the wire 1 segment by subjecting the wire -- which is constructed of any magnetizable material such as a ferromagnetic material, preferably specially processed 300 series stainless steel wire -- to an external magnetic field which has a sharp boundary. A suitable apparatus for subjecting the wire 1 segment to such a magnetic field is shown in Figs. 6 and 7. As shown in Figs. 6 and 7, a magnetizer **102** includes a pair of structurally identical iron, ferrite or alloy members **103**, **104** facing one another to form a magnetic gap **101**. Members **103** and **104** surround an energizing coil **100** wound on a bobbin (not shown). Energizing coil **100** is provided with a pair of energizing leads **106**. An electrical current is passed through the coil **100** in order to magnetize the wire 1 block within the gap **101** in the desired direction. The wire 1 may be advanced in a direction D by a motor **120** -- which may be a stepper motor, a DC servo control motor or any other appropriate motor --

controlled by a control unit 140 in the form of a microprocessor or other known control system, either the distance of a long block or the distance of a short block, as desired, and then the current in the coil 100 is reversed to magnetize the next adjacent region in the opposite direction. A counter 130 is connected to the motor 120 to detect the amount of wire 1 advanced by the motor 120 and to feed back information to the control unit 140. The control unit 140 is also coupled to a power source 150 for the coil, to control the energization of the coil 100 and the polarity of the magnetization of the wire 1 in conjunction with the advancement of the wire 1 by the motor 120. The magnetizer 102 may either lead or follow an apparatus 180 for visually coding the wire 1, which apparatus 180 can visually code the wire in the manner described in U.S. Patent No. 3,820,545, incorporated herein by reference. A reading device 190, including preferably the inductive element described below for reading the magnetic code on the wire 1, may follow the magnetizer 102 to thereby verify the code on the wire 1 as it is being manufactured. The reading device 190 can send signals to the control unit 140 for display purposes or for error correction.

The wire 1 is magnetically coded and encoded in the following manner. A pair of short blocks is used to code a binary 1 digit, while a long block is used to code a binary 0 digit. This coding corresponds to coding used in flat magnetic media (i.e., magnetic tape). The method by which the long and short blocks are used to produce binary 1 and 0 digits is explained with reference to Figs. 1-5. Fig. 1, as described above, shows a length of wire 1, with a series of short magnetic blocks 2_1, 2_2, 2_4, 2_5 and long magnetic blocks 2_3, 2_6, 2_7. Fig. 2 shows a graph of the strength of the external magnetic field H produced in the wire 1 segment shown in Fig. 1, along the length ℓ of the wire 1 segment. As seen in Fig. 2, the magnetic strength is strongest between the poles N and S, and changes directions at the location where two poles S/S or N/N of adjacent blocks 2 contact one another.

The technique by which the binary code represented by the blocks 2 in the wire 1 is encoded is represented in Figs. 3-5. A circuit, known to those skilled in the art of encoding binary magnetic data, including an inductive element is placed

adjacent the wire 1, which wire 1 is passed adjacent the inductive element at a constant velocity or which inductive element is passed by the wire 1 at a constant velocity. The circuit produces a signal V_i, corresponding to the voltage induced in the inductive element, which signal is proportional to the slope of the magnetic field strength H shown in Fig. 2. Locations where the magnetic field strength H is changing most rapidly (i.e., near the poles N, S of the blocks 2) produce the strongest signal, whereas locations where the magnetic field is the strongest and is not changing (i.e., between the poles N, S of the blocks 2) produces a zero signal. The signal produced by the circuit including the inductive element is shown in Fig. 3, which shows the voltage signal V_i along the length ℓ of the wire 1 segment.

Figs. 4 and 5 show the manner in which the processing circuitry of the encoding device for reading the wire 1 segment interprets the signal V_i from the inductive circuit. The first peak P_1 after the leader 2_0 is interpreted as a clock pulse C. Each subsequent pulse a specified distance ℓ_c along the length of the wire 1 segment (corresponding to a specified time interval resulting from the constant velocity passing of the wire 1 segment relative to the inductive element) is interpreted as a clock pulse C. The intervals between the clock pulses C are used to interpret binary data. A pulse between the clock pulses C is interpreted as a binary 1, while the lack of a pulse between two clock pulses C is interpreted as a binary 0. As shown in Fig. 5, a stream of binary data resulting from this encoding of the information from the voltage signal V_i is thereby derived, and may be used to interpret information stored on the wire 1 segment. At the end of the binary information recorded on the wire 1 segment, another sufficiently long section without an induced signal is used as a follower, or as an alternative an "end of wire" binary code is provided, to indicate that no more data is on the wire 1 segment.

In reading the magnetic pattern from the wire 1 segment, the reading device interprets a sufficiently long period without an induced signal peak in the inductive circuit as a leader section 2_0, and therefore prepares for the start of digital information. The first induced signal peak after the leader is read by the

reading device as a clock or timing signal, which marks the start of magnetically-coded information. Subsequent clock or timing signals will occur thereafter, spaced at intervals of equal length. These uniformly spaced clock peaks, as shown in Figs. 3 and 4, provide a timing framework within which other peaks, or the lack of a peak, are interpreted to encode magnetic binary information on the wire.

The encoding device which interprets the data on the wire 1 segment need not use an inductive element to extract data from the wire 1 segment. A direct detector of magnetic field may be used. In that case, the reversals of the magnetic field direction are used as the signal events (both clock pulses and digital signals), instead of induction peaks as described above. Other conventions besides the coding described above, which form a part of the art of digital magnetic recording, may be chosen instead of the coding described above, with appropriate changes of the magnetic coding and detection schemes.

In a preferred embodiment of the present invention, the length of a short magnetic block may be 3/4 of a millimeter, so that the distance between clock pulses is 1.5 millimeters. Preferably, when reading the magnetic information from the wire 1 as part of the injection procedure for wire tag segments, an individual magnetic record should be shorter than 24 millimeters (each tag segment, in contrast, is on the order of 1.07 millimeters in length). Thus, a record containing no more than 16 bits is preferred. In the preferred embodiment, a record of 12 bits in length is used, organized in a data format xxxxyzzzzzzz. The data segment xxxx is a four-bit record type number indicating the type of tag on the wire; y is a parity bit for error control; and zzzzzzz is a seven-bit field of data, which may be chosen to represent one field of the data encoded visually on the wire surface for each tag segment on the wire. As will be described below, the process of injecting the tag segments T into a macro-organism destroys the magnetic code on the wire 1 as the wire 1 is turned into tag segments T.

A portion of the apparatus 600 for injecting tag segments T into a macro-organism is shown in Fig. 8. The apparatus 600 contains a cutting device structure 601 identical to that described in U.S. Patent No. 4,679,559. A magnetizer/reader coil 102 is disposed downstream of a cutting device 601. The

magnetizer/reader coil 102 magnetizes the wire 1 into magnetic block segments, to thereby create magnetized wire tags T as well as an adjacent wire 1 leader to assist in injection of the wire tag T into macro-organism M. Wire 1 is guided to the cutting device 601 through a wire guide 640. Upon the positioning of a leading end portion of wire 1 within a rotatable component 644 of a rotary shear 642, the rotatable component is pivoted to sever the leading end portion of wire 1 to form tag T. The rotatable component 644 is then rotated back until tag T is realigned with wire 1. The tag T may be advanced, by movement of wire 1, into an injection needle 612, and thereafter into macro-organism M. The magnetizer/reader coil 102 creates a new magnetization on the tag segment T at the end of wire 1. The polarities of this magnetization pattern are used, as described in U.S. Patent No. 4,679,559, to assist in the implantation of the tags T into the macro-organism. In operation of the apparatus 600, the wire 1 retracts into the cutting device 601 to have a tag T cut off at the end. The wire 1 then advances to push the tag T ahead into the magnetizer/reader coil 102, where the magnetizer/reader coil 102 is engergized to magnetize the tag T. The wire 1 is then advanced an increment, and the magnetizer/reader coil 102 is then energized, with a reversed polarity, so that the end of wire 1 repels the tag T. The magnetizer/reader coil 102 is then de-energized, and wire 1 is advanced to inject the tag T into the macro-organism M. As the wire 1 is advanced through magnetizer/reader coil 102 to inject tag T, or as wire 1 is subsequently retracted, the magnetizer/reader coil 102 may be used to read coded binary data on wire 1. A reading coil could alternatively placed on both sides of cutting device 601.

Magnetizer/reader coil 102 is a coil which is also used in conjunction with a reading device 190. Reading device 190 uses the magnetizer/reader coil 102 as an inductive element which may be coupled by a switch 194 to known circuitry 192 for translating induced voltages into clock pulses and binary data, in the manner described above. The switch 194 controls whether magnetizer/reader coil 102 is coupled to the circuitry 192 for use as an inductive sensor or is coupled to a voltage source V for energizing magnetizer/reader coil 102 to provide magnetization to wire 1. The circuitry 192 may be coupled to a display device 193

for displaying information encoded from the wire 1 by reading device **190**. A processor or computer **195** may be used to process signals from circuitry **192**, as well as to control switch **194** to control whether magnetizer/reader coil 102 coil is used as a magnetizer or an inductive sensor.

It is to be understood that numerous alternatives and variations of the wire, coding, tags, manufacturing equipment and reading equipment are possible under the scope of the present invention, and that the above description is of a preferred embodiment. The scope of the present invention is defined by the claims below.

CLAIMS

1. A medium for storing digital data comprising:

a wire, said wire being made of a magnetizable material, said wire being magnetized to form a plurality of magnetic blocks, each block having two magnetic poles, each of said magnetic poles of one of said blocks being located adjacent the pole of an adjacent block having the same polarity.

2. The medium of claim 1, wherein:

said blocks comprise short blocks and long blocks, a length of two of said short blocks being equal to a length of one of said long blocks.

3. The medium of claim 2, wherein:

each of said short blocks are adjacent at least one other short block.

4. The medium of claim 3, wherein:

two adjacent short blocks comprise a binary 1, and wherein each of said long blocks comprises a binary 0.

5. The medium of claim 1, wherein:

an outer surface of said wire is visually coded with digital information.

6. A method of coding digital data, comprising the steps of:

providing a wire made of a magnetizable material;

magnetizing said wire to form a plurality of magnetic blocks, each block having two magnetic poles, each of said magnetic poles of one of said blocks being located adjacent the pole of an adjacent block having the same polarity.

7. The method of claim 6, wherein:

said step of magnetizing said wire comprises forming short blocks and long blocks, and wherein said step of forming short blocks and long blocks comprises

forming two of said short blocks having a length equal to a length of one of said long blocks.

8. The method of claim 7, wherein:

said step of magnetizing said wire comprises forming each of said short blocks adjacent to at least one other short block.

9. The method of claim 8, wherein:

said step of magnetizing said wire comprises providing two adjacent short blocks to comprise a binary 1, and providing each of said long blocks to comprise a binary 0.

10. The method of claim 6, further comprising the step of:

visually coding an outer surface of said wire with digital information.

11. A medium for tagging macro-organisms comprising:

a wire, said wire being made of a magnetizable material, said wire being magnetized to form a plurality of magnetic blocks, each block having two magnetic poles, each of said magnetic poles of one of said blocks being located adjacent the pole of an adjacent block having the same polarity, an outer surface of said wire being visually coded with digital information.

12. The medium of claim 11, wherein:

said blocks comprise short blocks and long blocks, a length of two of said short blocks being equal to a length of one of said long blocks, each of said short blocks being adjacent at least one other short block.

13. The medium of claim 12, wherein:

two adjacent short blocks comprise a binary 1, and wherein each of said long blocks comprises a binary 0.

14. The medium of claim 11, wherein:

said visual information in provided on a segment of said wire of a predetermined length, said predetermined length being approximately equal to the length of a tag implanted into said macro-organism.

15. The medium of claim 11, wherein:

said magnetic blocks define a code of binary information, said code of binary information defined by said magnetic blocks comprising information identical to said visually coded digital information.

16. The medium of claim 15, wherein:

said code of binary information defined by said magnetic blocks also comprises additional information.

17. An apparatus for manufacturing a medium for tagging macro-organisms, said medium comprising a wire made of a magnetizable material, said apparatus comprising:

a magnetizer, said magnetizer magnetizing segments of said medium, said magnetized segments comprising a first digital code;

a visual coding device, said visual coding device providing indentations on an outer surface of said medium, said indentations forming a second digital code; and

a reading device, said reading device reading said first digital code.

18. An apparatus for injecting tags made of a wire comprising a magnetic code into a macro-organism, said apparatus comprising:

a reading device, said reading device encoding said magnetic code from said wire;

a magnetizer, said magnetizer magnetizing equal-length segments of said wire;

a cutter, said cutter cutting each said equal-length segment into a tag; and

an injection needle.

ABSTRACT 2189595

A device for tagging a macro-organism, particularly a fish, with a tag including visually-readable binary information. The information is coded on a wire, which is implantable on the macro-organism for later reading. The wire from which the tags are made is additionally magnetically coded, so that a reading and verification device can be used during manufacture and just prior to tag implantation to verify information relative to the tags and wire used. The present invention also relates to a method for producing and using such a tag and wire.

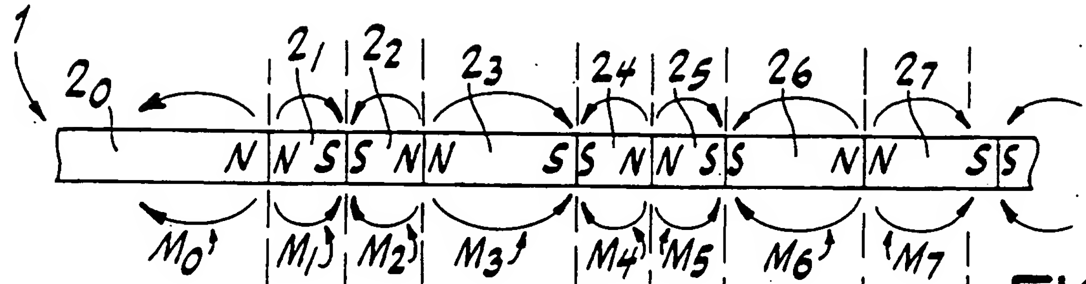

FIG. 1

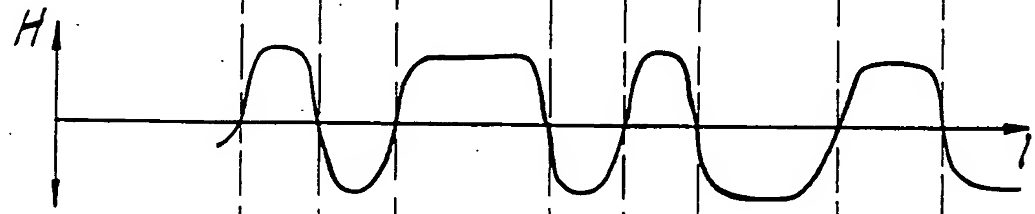

FIG. 2

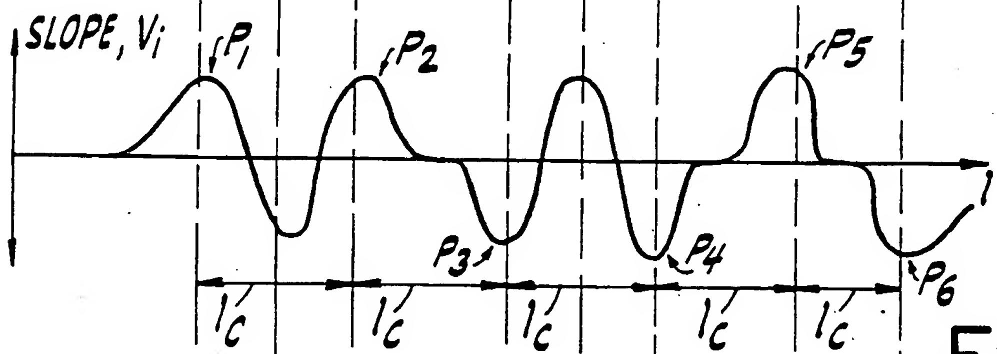

FIG. 3

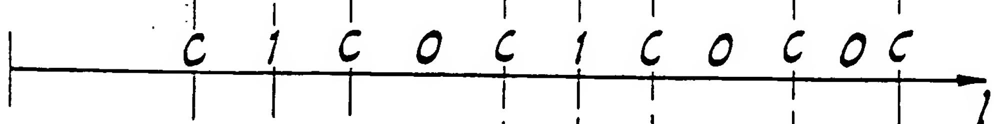

FIG. 4

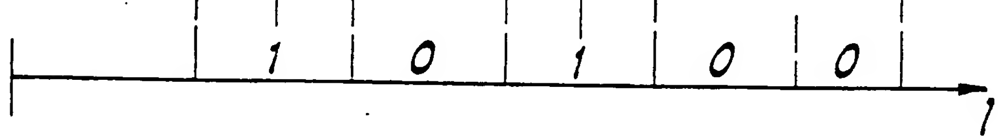

FIG. 5

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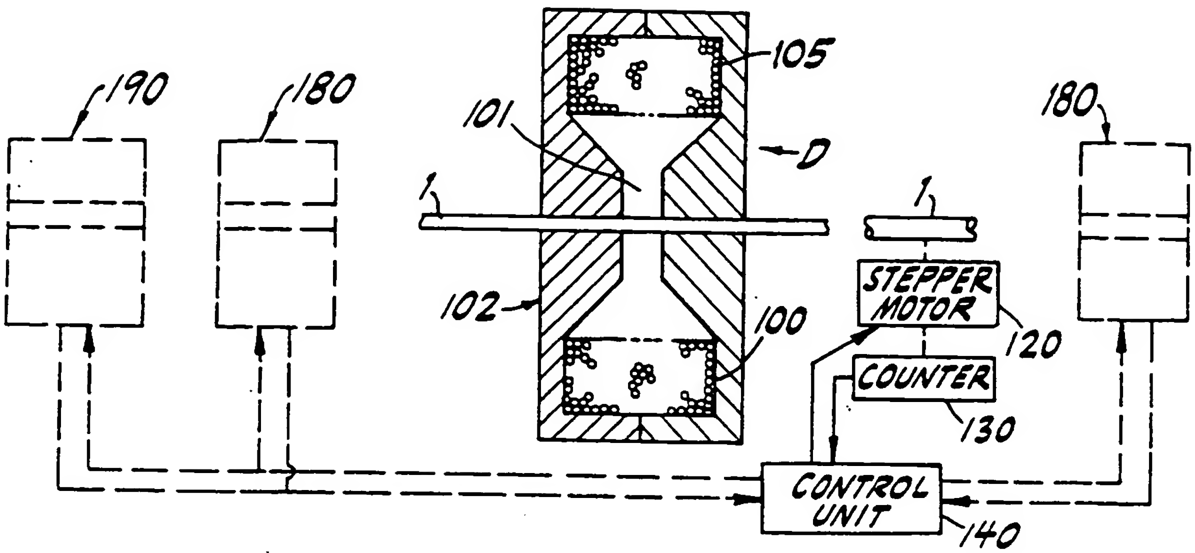

FIG. 6

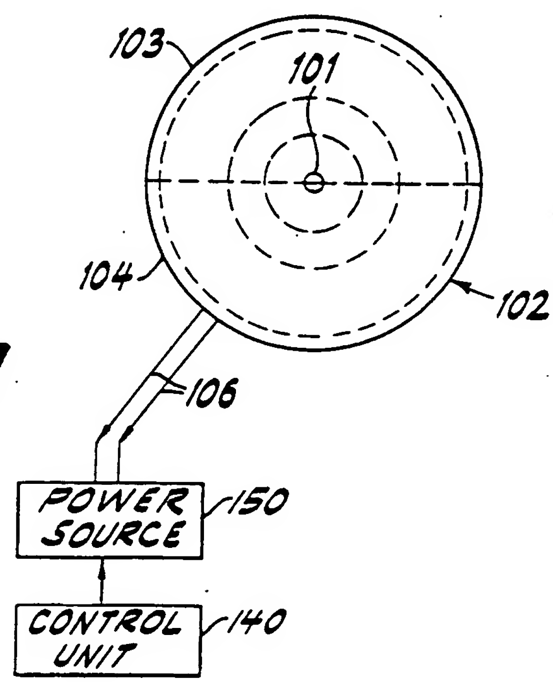

FIG. 7

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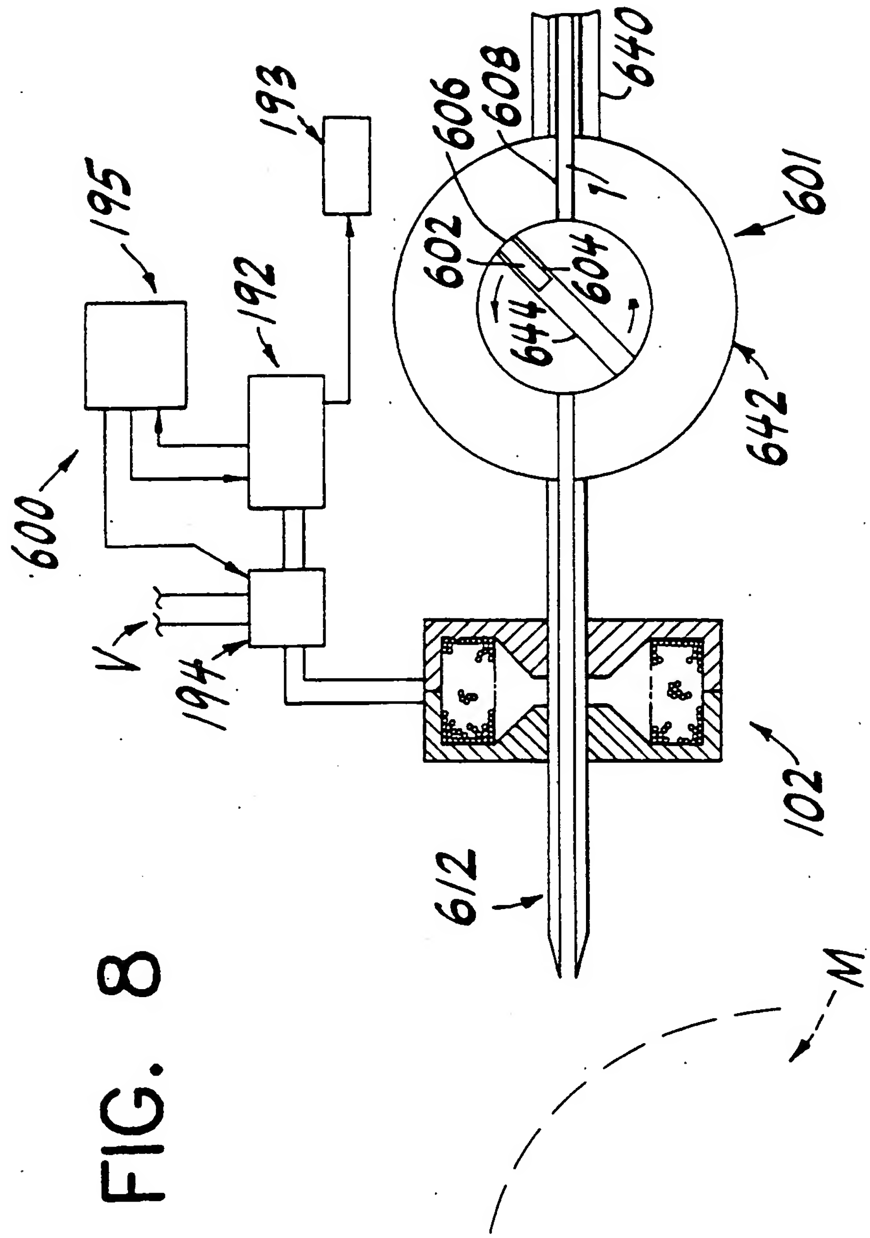

FIG. 8